

006.39 Mathematics

006.39A Grade Levels: ~~7~~6-12

006.39B Endorsement Type: Field

006.39C Persons with this endorsement may teach mathematics in grades ~~7~~ 6 through 12.

006.39D Certification Endorsement Requirements: This endorsement shall require a minimum of ~~30~~ 36 semester hours of mathematics.

006.39E Endorsement Program Requirements: Nebraska teacher education institutions offering this endorsement program must have on file, within the institution, a plan which identifies the courses and the course completion requirements which the institution utilizes to grant credit toward completion of this endorsement.

***THE FOLLOWING ARE RECOMMENDED GUIDELINES FOR
INCLUSION AS PART OF THE INSTITUTION'S PLAN
UNDER THIS ENDORSEMENT.***

Through the courses identified in its plan, the institution ~~should~~ will prepare prospective teachers ~~to demonstrate the following criteria~~ according to the 2012 standards of the National Council of Teachers of Mathematics (NCTM) to:

A. Demonstrate knowledge and understanding of and ~~be able~~ ability to teach the concepts, skills, and processes of mathematics as defined in the Nebraska Content Standards for eighth and twelfth grades as per NAC 92 Rule 10.

B. (NCTM) Standard 1. Content Knowledge. Effective teachers of secondary mathematics understand and demonstrate and apply knowledge of major mathematics concepts, algorithms, procedures, connections, and applications within and among mathematical domains. They understand the influence of curriculum standards on the mathematical content knowledge needed for teaching secondary (6-12) students.

Preservice teacher candidates:

- 1.a) Demonstrate and apply knowledge of major mathematics concepts, algorithms, procedures, applications in varied contexts, and connections within and among mathematical domains (Number, Algebra, Geometry, Trigonometry, Statistics, Probability, Calculus, and Discrete Mathematics) as outlined in the NCTM NCATE Mathematics Content for Secondary (listed below); and

- 1.b) Demonstrate an understanding of curriculum standards for mathematics and their impact on the mathematical content knowledge necessary for teaching secondary students.

All secondary mathematics teachers are prepared with depth and breadth in the following mathematical domains: Number, Algebra, Geometry, Trigonometry, Statistics, Probability, Calculus, and Discrete Mathematics. All teachers certified in secondary mathematics will know, understand, and teach with the breadth of understanding reflecting the following competencies for each of these domains:

1. **Number and Quantity.** All secondary mathematics teachers are prepared to develop student proficiency with the following topics related to number and quantity:
 - 1.1 Structure, properties, relationships, and operations including standard and non-standard algorithms on various types of numbers and number systems, including integer, rational, irrational, real, and complex numbers;
 - 1.2 Fundamental ideas of number theory (divisors, factors and factorization, primes, composite numbers, greatest common factor, least common multiple, and modular arithmetic)
 - 1.2 Quantitative reasoning and relationships that include ratio, rate, and proportion and the use of units in problem situations;
 - 1.3 Vector and matrix operations, modeling, and applications;
 - 1.4 Utilization of technological tools to explore number and quantity; and
 - 1.5 Historical development and perspectives of number, number systems, and quantity including contributions of significant figures and diverse cultures.
2. **Algebra.** All secondary mathematics teachers are prepared to develop student proficiency with the following topics related to algebra:
 - 2.1 Algebraic notation, symbols, expressions, equations, inequalities, and proportional relationships, and their use in describing, interpreting, and modeling relationships;
 - 2.2 Function classes including polynomial, exponential and logarithmic, rational, periodic, and discrete and how the choices of parameters determine particular cases and model specific situations;
 - 2.3 Functional representations (tables, graphs, equations, descriptions, recursive definitions, and finite differences) and notations as a means to describe, interpret, and analyze relationships and to build new functions;

- 2.4 Patterns of change in linear, quadratic, polynomial, and exponential functions and in proportional and inversely proportional relationships and types of real-world relationships these functions can model;
 - 2.5 Linear algebra including vectors, matrices, and transformations;
 - 2.6 Abstract algebra including groups, rings, and fields and the relationship between these structures and formal structures for number systems and numerical and symbolic calculations;
 - 2.7 Utilization of technological tools to explore algebraic ideas, individual functions, and classes of related functions and to solve problems; and
 - 2.8 Historical development and perspectives of algebra including contributions of significant figures and diverse cultures.
3. **Geometry and Trigonometry.** All secondary mathematics teachers are prepared to develop student proficiency with the following topics related to geometry and trigonometry:
- 3.1 Core concepts and principles of Euclidean geometry in two and three dimensions and examples of non-Euclidean geometry;
 - 3.2 Transformations including dilations, translations, rotations, reflections, glide reflections, and the expression of symmetry in terms of transformations;
 - 3.3 Congruence, similarity and scaling, and their development and expression in terms of transformations;
 - 3.4 Right triangles and trigonometry;
 - 3.5 Application of periodic phenomena and trigonometric identities;
 - 3.6 Identification, classification into categories, visualization, and representation of two- and three-dimensional objects (triangles, quadrilaterals, regular polygons, prisms, pyramids, cones, cylinders, and spheres);
 - 3.7 Formula rationale and derivation (perimeter, area, and volume) of two- and three-dimensional objects (triangles, quadrilaterals, regular polygons, prisms, pyramids, cones, cylinders, and spheres), with attention to units, unit comparison, and the iteration, additivity, and invariance related to measurements;
 - 3.8 Geometric constructions, axiomatic reasoning, and proof;

- 3.9 Analytic and coordinate geometry including algebraic proofs (e.g., the Pythagorean Theorem and its converse) and equations of lines and planes, and expressing geometric properties of conic sections with equations;
 - 3.10 Utilization of concrete models and dynamic technological tools to conduct geometric and trigonometric investigations that emphasize visualization, recognizing patterns, conjecturing, and proof and to model and solve problems; and
 - 3.11 Historical development and perspectives of geometry and trigonometry including contributions of significant figures and diverse cultures.
4. **Statistics and Probability.** All secondary mathematics teachers are prepared to develop student proficiency with the following topics related to statistics and probability:
- 4.1 Statistical variability and its sources and the role of randomness in statistical inference;
 - 4.2 Creation and implementation of surveys and investigations using sampling methods and statistical designs, statistical inference (estimation of population parameters and hypotheses testing), justification of conclusions, and generalization of results;
 - 4.3 Construction and interpretation of graphical displays of univariate data Distributions (e.g. box plots, histograms, and cumulative frequency plots); summary measures and comparison of distributions of univariate data, and exploration of bivariate and categorical data;
 - 4.4 Empirical and theoretical probability (discrete, continuous, and conditional) for both simple and compound events;
 - 4.5 Random (chance) phenomena, simulations, and probability distributions and their application as models of real phenomena and to decision making;
 - 4.6 Utilization of technological tools to explore statistical ideas, represent information, create simulations, and solve problems; and
 - 4.6 Historical development and perspectives of statistics and probability including contributions of significant figures and diverse cultures.
5. **Calculus.** All secondary mathematics teachers are prepared to develop student proficiency with the following topics related to calculus:
- 5.1 Limit, continuity, and the techniques and applications of differentiation and integration;

- 5.2 Parametric, polar, and vector functions;
 - 5.3 Sequences and series;
 - 5.4 Multivariate functions;
 - 5.5 Applications of function, geometry, and trigonometry concepts to solve problems involving calculus;
 - 5.6 Utilization of technological tools to explore and represent fundamental concepts of calculus and to solve problems taken from real-world contexts; and
 - 5.7 Historical development and perspectives of calculus including contributions of significant figures and diverse cultures.
6. **Discrete Mathematics.** All secondary mathematics teachers are prepared to develop student proficiency with the following topics related to discrete mathematics:
- 6.1 Discrete structures including sets, relations, functions, graphs, trees, and networks;
 - 6.2 Enumeration including permutations, combinations, iteration, recursion, and finite differences;
 - 6.3 Propositional and predicate logic;
 - 6.4 Applications of discrete structures such as modeling and solving linear programming problems and designing data structures;
 - 6.5 Utilization of technological tools to solve problems involving discrete structures, the application of algorithms, and programming; and
 - 6.5 Historical development and perspectives of discrete mathematics including contributions of significant figures and diverse cultures.
- C. (NCTM) Standard 2. Mathematical Practices.** Effective teachers of secondary mathematics know and understand the importance of problem solving, reasoning and proof, modeling, attending to precision, identifying elements of structure, generalizing, engaging in mathematical communication, and making connections as essential mathematical practices. They understand that these practices intersect with mathematical content and that understanding of mathematical content relies on the ability to demonstrate these practices within and among mathematical domains and in their teaching.
- Preservice teacher candidates:
- 2.a) Use problem solving to develop conceptual understanding, make sense of a wide variety of problems and persevere in solving them, apply and

adapt a variety of strategies in solving problems confronted within the field of mathematics and other contests, and formulate and test generalizations.

- 2.b) Reason abstractly, reflectively, and quantitatively with attention to units, constructing viable arguments and proofs, and critiquing the reasoning of others; represent and model generalizations using mathematics; recognize structure and express regularity in patterns of mathematical reasoning; and use multiple representations to model and describe mathematics; and utilize appropriate mathematic vocabulary and symbols to communicate mathematical ideas to others;
- 2.c) Formulate, represent, analyze, and interpret mathematical models derived from real-world contexts or mathematical problems.
- 2.d) Organize mathematical thinking and use the language of mathematics to express ideas precisely, both orally and in writing to **diverse** audiences; (Original wording is "multiple audiences")
- 2.e) Demonstrate the interconnectedness of mathematical ideas and how they build on one another and recognize and apply mathematical connections among mathematical ideas and across various content areas and real-world contexts; and
- 2.f) Model how the development of mathematical understanding within and among mathematical domains intersects with the mathematical practices of problem solving, reasoning, communicating, connecting, and representing.

D. (NCTM) Standard 3. Content Pedagogy. Effective teachers of secondary mathematics apply knowledge of curriculum standards for mathematics and their relationship to student learning within and across mathematical domains. They incorporate research-based mathematical experiences and include multiple instructional strategies in their teaching to develop all students' mathematical understanding and proficiency. They provide students with opportunities to do mathematics – talking about it and connecting it to both theoretical and real-world contexts. They plan, select, and implement formative and summative assessments for monitoring student learning, measuring student mathematical understanding, and informing practice.

Preservice teacher candidates:

- 3.a) Apply knowledge of curriculum standards for secondary mathematics and their relationship to student learning within and across mathematical domains;
- 3.b) Analyze and consider research in planning for and leading students in rich

mathematical experiences;

- 3.c) Plan lessons and units that incorporate a variety of strategies, differentiated instruction for diverse populations, and mathematics-specific and instructional technologies in building all students' conceptual understanding and procedural fluency; (original word was proficiency)
- 3.d) Provide all students with opportunities to communicate about mathematics and make connections among mathematics, other content areas, everyday life, and the workplace;
- 3.e) Implement techniques related to student engagement and communication including selecting high quality tasks, identifying student misconceptions, and employing a range of questioning strategies;
- 3.f) Plan, select, and implement formative and summative assessments reflecting mathematical knowledge, skills, understanding, and performance that are essential for all students; and
- 3.g) Monitor all students' progress, make instructional decisions, and measure all students' mathematical understanding and ability using formative and summative assessments.

E. (NCTM) Standard 4. Mathematical Learning Environment. Effective teachers of secondary mathematics exhibit in-depth knowledge of adolescent development and behavior and use this knowledge to plan and create sequential learning opportunities grounded in mathematics education research where students are actively engaged in the mathematics they are learning and building from prior knowledge and skills. They demonstrate a positive disposition toward mathematical practices and learning, including culturally relevant perspectives in teaching, and demonstrate equitable and ethical treatment of and have high expectations for all students. They use instructional tools such as manipulatives, digital tools, and virtual resources to enhance learning while recognizing the possible limitations of such tools.

Preservice teacher candidates:

- 4.a) Exhibit in-depth knowledge of adolescent development and behavior and demonstrate a positive disposition toward mathematical processes and learning;
- 4.b) Plan and create developmentally appropriate, sequential, and challenging learning opportunities grounded in mathematics education research in which all students are actively engaged in building new knowledge;
- 4.c) Incorporate knowledge of individual differences and the cultural diversity that exists within classrooms and include culturally relevant perspectives as a means to motivate and engage students;

- 4.d) Demonstrate equitable and ethical treatment of and high expectations for all students;
- 4.e) Apply mathematical content and pedagogical knowledge to select and use instructional tools such as manipulatives and physical models, drawings, virtual environments, spreadsheets, presentation tools, and mathematics-specific technologies (e.g., graphing tools, interactive geometry software, computer algebra systems, and statistical packages, and others); and make sound decisions about when such tools enhance teaching and learning, recognizing both the insights to be gained and possible limitations of such tools.

F. (NCTM) Standard 5. Impact on Student Learning. Effective teachers of secondary mathematics provide evidence demonstrating that as a result of their instruction, which supports the continual development of a productive disposition toward mathematics, secondary students' conceptual understanding, procedural fluency, strategic competence, adaptive reasoning, and application of major mathematics concepts in varied contexts have increased. These teachers show that new student mathematical knowledge has been created as a consequence of their ability to engage students in mathematical experiences that are developmentally appropriate, require active engagement, and include mathematics-specific technology in building new knowledge.

Preservice teacher candidates:

- 5.a) Verify that secondary students demonstrate conceptual understanding; procedural fluency; the ability to formulate, represent, and solve problems; logical reasoning and continuous reflection on that reasoning; productive disposition toward mathematics; and the application of mathematics in a variety of contexts within major mathematical domains;
- 5.b) Engage students in developmentally appropriate mathematical activities and investigations that require active engagement and include mathematics-specific technology in building new knowledge; and
- 5.c) Collect, organize, analyze, and reflect on diagnostic, formative, and summative assessment evidence and determine the extent to which students' mathematical knowledge, skills, understandings, and performance have increased as a result of their instruction.

G. (NCTM) Standard 6. Professional Knowledge and Skills. Effective teachers of secondary mathematics are lifelong learners and recognize that learning is often collaborative. They participate in professional development experiences specific to mathematics and mathematics education, draw upon mathematics education

research to inform practice, continuously reflect on their practice, and utilize resources from professional mathematics organizations.

Preservice teacher candidates:

- 6.a) Take an active role in their professional growth by participating in professional development experiences that directly relate to the learning and teaching of mathematics;
- 6.b) Engage in continuous and collaborative learning that draws upon research in mathematics education to inform practice; enhance all students' knowledge of mathematics; involve colleagues; other school professionals, families, and various stakeholders; and advance their development as a reflective practitioner; and
- 6.c) Utilize resources from professional mathematics education organizations such as print, digital, and virtual resources/collections.

H. (NCTM) Standard 7. Secondary Mathematics Field Experiences and Clinical Practice. Effective teachers of secondary mathematics engage in a planned sequence of field experiences and clinical practice under the supervision of experienced and highly qualified mathematics teachers. They develop a broad experiential base of knowledge, skills, effective approaches to mathematics teaching and learning, and professional behaviors across both middle and high school settings that involve a diverse range and varied groupings of students. Candidates experience a full-time student teaching experience in secondary mathematics directed by university or college faculty with secondary mathematics teaching experience or equivalent knowledge base.

Preservice teacher candidates:

7.a) Engage in a sequence of planned field experiences and clinical practice prior to full-time student teaching experience that include observing and participating in both middle and high school mathematics classrooms under the supervision of experienced and highly qualified mathematics teachers and in varied settings that reflect cultural, ethnic, gender, and learning differences.

7.b) Experience full-time student teaching in secondary mathematics that is supervised by a highly qualified mathematics teacher and a university or college supervisor with secondary mathematics teaching experience or equivalent knowledge base.

7.c) Develop knowledge, skills, and professional behavior across both middle and high school settings; examine the nature of mathematics, how mathematics should be taught, and how students learn mathematics; observe and analyze a range of approaches to mathematics teaching and learning, focusing on tasks, discourse, environment, and assessment; and work with a diverse range of students individually, in small groups, and in large class settings.

- ~~B. Demonstrate an understanding of and be able to apply the processes of mathematics, including being able to:~~
- ~~1. Use problem-solving approaches to investigate and understand mathematical content;~~
 - ~~2. Formulate and solve problems from both mathematics and everyday situations;~~
 - ~~3. Communicate mathematical ideas orally and in writing using everyday language, mathematical language, symbols, and graphs;~~
 - ~~4. Make mathematical conjectures, evaluate arguments and validate mathematical thinking;~~
 - ~~5. Examine relationships within mathematics;~~
 - ~~6. Connect mathematics to other disciplines and real-world situations;~~
 - ~~7. Use technology in exploration, computation, graphing, and problem solving; and~~
 - ~~8. Use instructional strategies based on current research as well as national, state, and local standards relating to mathematics instruction.~~

~~Demonstrate an understanding of and be able to apply the concepts and principles of mathematics, including being able to:~~

- ~~7. Apply concepts of number, number theory, and number systems;~~
- ~~8. Apply numerical computation and estimation techniques and extend them to algebraic expressions;~~
- ~~9. Use geometric concepts and relationships to describe and model mathematical ideas and real-world constructs;~~
- ~~10. Use both descriptive and inferential statistics to analyze data, make predictions, and make decisions;~~
- ~~11. Demonstrate an understanding of the concepts of theoretical and simulated probability and apply them to real-world situations;~~
- ~~12. Use algebra to describe patterns, relations, and functions and to model and solve problems;~~

- ~~13. Recognize the roles of axiomatic systems and proofs in different branches of mathematics, such as algebra and geometry;~~
 - ~~14. Demonstrate an understanding of the concepts of limit, continuity, differentiation, and integration, and the techniques and applications of calculus;~~
 - ~~15. Demonstrate an understanding of the concepts and applications of discrete mathematics such as graph theory, matrices, recurrence relations, linear programming, difference equations, and combinatorics;~~
 - ~~16. Use mathematical modeling to solve problems from other fields such as natural sciences, social sciences, business, and engineering;~~
 - ~~17. Demonstrate an understanding of and be able to apply the major concepts of geometry;~~
 - ~~18. Demonstrate an understanding of and be able to apply the major concepts of linear algebra;~~
 - ~~19. Demonstrate an understanding of and be able to apply the major concepts of abstract algebra; and~~
 - ~~20. Demonstrate an understanding of the historical development in mathematics that includes the contributions of under-represented groups and diverse cultures.~~
- ~~**B.** The program for prospective teachers may include the following coursework: Pre-calculus, Calculus, Logic/Foundations, Linear Algebra, College Geometry, Probability and Statistics, Discrete/Finite Mathematics, History of Mathematics, Abstract Algebra, and Computer Programming and Applications.~~

Ad Hoc Committee—February 16, 2012

DRAFT # 1

DRAFT #2—February 17, 2012

DRAFT #3—February 29, 2012

REDLINE VERSION

Updated NCTM NCATE Language—9.5.12

**Mathematics
Endorsement Guidelines
To Accompany Rule 24
(Adopted by the State Board
of Education on 11/9/01)**

MATHEMATICS AD HOC MEMBERSHIP FORM

(Based on Section 17.03 of the NCTE Organizational Policies)

Thursday, February 16, 2012—10 AM-4 PM Country Inn & Suites, Lincoln—Lighthouse Room

MEMBERSHIP CRITERIA	NOMINEES
17.03A Three practitioners currently endorsed and employed in approved or accredited public or private schools in the endorsement area under consideration	1. Shelby Aaberg—Scottsbluff High School (D7) 2. Helen Banzhaf—Seward High School (D5) 3. Tami Heiser, Santee Public (D3) (Could not attend—illness)
17.03B At least two faculty members from a college or department of education who are teaching professional education courses at an approved professional training institution	1. Tami Worner, WSC (D3) 2. Elliott Ostler, UNO (D8)
17.03C Two specialists in the area which might include academic college professors, learned society officers, or persons drawn from related professions	1. JaLena Slack—ESU 8 (D6) 2. Beth Wentworth—CSC (D7)
17.03D Two teachers currently employed and endorsed in approved or accredited public or private schools at the grade levels and/or subject matter under consideration	1. Cherrie (Cummings) Kerr—Fremont High School (D3) 2. Otis Pierce—Sutherland High School (D7)
17.03E Two school administrators currently employed in approved or accredited public or private schools at the grade levels under consideration. At least one of the administrators must represent District Classes 2 or 3	1. Lincoln or Omaha administrators Jim Harrington, OPS Mathematics Supervisor (D4) 2. Classes 2 or 3 Dick Meyer, Kearney Public (D6) (Could not attend—illness)
17.03F One person representing the general public, e.g. PTA member or a school board member	De Tonack, Lincoln (D1)
17.03G One member of the NCTE Undergraduate or Graduate Committee, whichever is applicable.	(Anna) Chris Gay, LPS (D1)
17.03H One representative of NDE	Deb Romanek (D1) deb.romanek@nebraska.gov
17.03I Additional representatives if it is a field endorsement containing multiple subject endorsements	N/A for this Ad Hoc
17.03J Additional approved or accredited public or private school practitioners or higher education faculty members to equalize the representation between these two groups	Pari Ford, UNK (D6) Janice Rech, UNO (D8) Dave Fowler, UN-L (retired) (D1) Kass Rempp, Hastings College (D6) Jim Johnson, Doane College (D5) Julie (Brandt) Lodes, Plattview High School (D2)
17.03K The NDE designee, who will be a non-voting member and serve as a consultant for the committee	Marge Harouff, NDE Consultant Sharon Katt, NDE Pat Madsen, NDE, Marlene Beiermann, NDE

Ad Hoc Discussion Notes:

Ad Hoc Committee recommends changing grade level of this endorsement to 6-12, because of mathematics concepts now being taught at 6th-8th grade levels, National Council of Teachers of Mathematics also recommends 6-12. Currently, a NE-endorsed 7-12 teacher can teach 6th grade courses (Rule 10 accreditation.)

Credit hours: Changed minimum requirement from 30 to 36 credit hours (beginning with Calculus II.)

Ad Hoc Committee—February 16, 2012

DRAFT # 1

DRAFT #2—February 17, 2012

DRAFT #3—February 29, 2012

REDLINE VERSION

Updated NCTM NCATE Language—9.5.12

Candidates must be prepared to teach according to NCTM Standards and also the NE Content Standards for grades 6-12. Candidates should also be familiar with K-5 NE Content Standards. (NE has not yet adopted the Common Core Standards.) Preparation programs should be standardized for all candidates, since there are now state and national student mathematics standards for all grades.

Ad Hoc Committee went through each standard and made few revisions in language (2/7/2012 version is now used). NCTM Standards are still in draft form and are to be approved by NCTM in April, 2012 and then adopted by NCATE in October, 2012. The Ad Hoc Committee did agree that if there were changes in the NCTM Standards after April, they should also be reflected in the Guidelines and the Ad Hoc members would be notified.

Discussion also included how many calculus courses should be required, with the final decision being that Calculus III did not need to be a program requirement for preparation programs for teaching secondary mathematics. With the numbers of college students having to take remedial mathematics courses in college, perhaps more preparation needs to include teaching strategies and methods, especially for students who struggle with mathematics.

Professional development of mathematics teachers was also discussed. Very few mathematics teachers get their masters degree in mathematics. Candidates tend to get their masters degrees in Curriculum and Instruction or Administration, which is somewhat of a problem for the mathematics field.

**Mathematics
Endorsement Guidelines
To Accompany Rule 24
(Adopted by the State Board
of Education on 11/9/01)**